

Build a Radio Frequency Field Strength Meter

By Fred Blechman

You can detect signals within a broad range of radio frequencies with this device, which can be built from a kit or from the information in this article. Although not as sensitive as security devices for detecting low-power "bugs," this unit can be very useful for determining if transmitting devices are operating. Radio amateurs and experimenters can use the RF Meter for tuning oscillators, transmitters, and antennas for maximum output.

It's all around us. You can't feel it, you can't see it, and you can't hear it, yet we are figuratively swimming in a sea of radio frequency (RF) energy! Well, with the right equipment you CAN actually SEE it — with a television set, for example. Or at an Air Control Tower or Center on cathode ray tubes. Or on a Global Positioning Satellite (GPS) receiver's screen.

And you can certainly HEAR it on an AM or FM standard broadcast radio receiver — and even more on a shortwave or amateur radio receiver. And a radar detector can let you know you're being scanned with high-frequency for possible speeding in your car.

However, without some sort of detecting and display or output device, the radio frequencies that constantly invade, penetrate, and pass through our bodies are not noticeable. Of course, in EXTREME exposure the effects can be harmful, and even the radiation from cell phones held against your ear are suspect. Generally, however, we are neither aware of, nor harmed by, RF signals.

RF Field Strength Meter

It is handy — in building or testing equipment that produces radio frequencies — to have a device that will indicate the relative strength of the signal. For example, one very practical application is tuning a transmitter and its antenna for maximum radiation.

The RF Field Strength Meter described here is a wide-band detector that indicates field strength in the 100KHz to 500MHz range at relatively low levels. The RF power reading — shown on an analog meter — is not linear, and simply indicates relative strength. The circuit has an adjustable attenuator to handle fields of different levels.



Every part needed is furnished with the RF Meter Kit from LNS Technologies.

The Kit

I've written before about LNS Technologies' kits. They are exceptionally well designed, and come complete with all the necessary parts and detailed assembly and operational instructions. The LNS "RFMETER-KIT" includes an etched and drilled circuit board, all the necessary components (except for a nine-volt battery), a pre-drilled bakelite cabinet, a tubular antenna, and a large analog meter.

All the information is provided here — including a printed circuit board layout and parts layout — so that you can build this RF Meter from scratch. The Parts List uses mostly common parts, but you might have some trouble finding the TLC272CP Dual Op-Amp IC (integrated circuit). It is specially designed for high-frequency capability, and getting it from a catalog house could mean paying for a minimum order plus shipping. The same applies to the 50 microampere panel-mounted analog meter. For this reason, the Parts List also offers some of the special parts separately.

Theory of Operation

Figure 1 is the schematic of the RF Meter. The circuit consists of a power supply, a current-to-voltage converter, a detector, and a moving coil meter.

The circuit is powered from a single battery and the switch, S1, mounted on VR1, and stabilized by capacitors C3 and C5. When the switch is closed, resistors R3 and R4 form a high impedance voltage divider to provide a reference voltage of half the supply voltage. With a nine-volt battery, the reference voltage is 4.5 volts. (This reference was

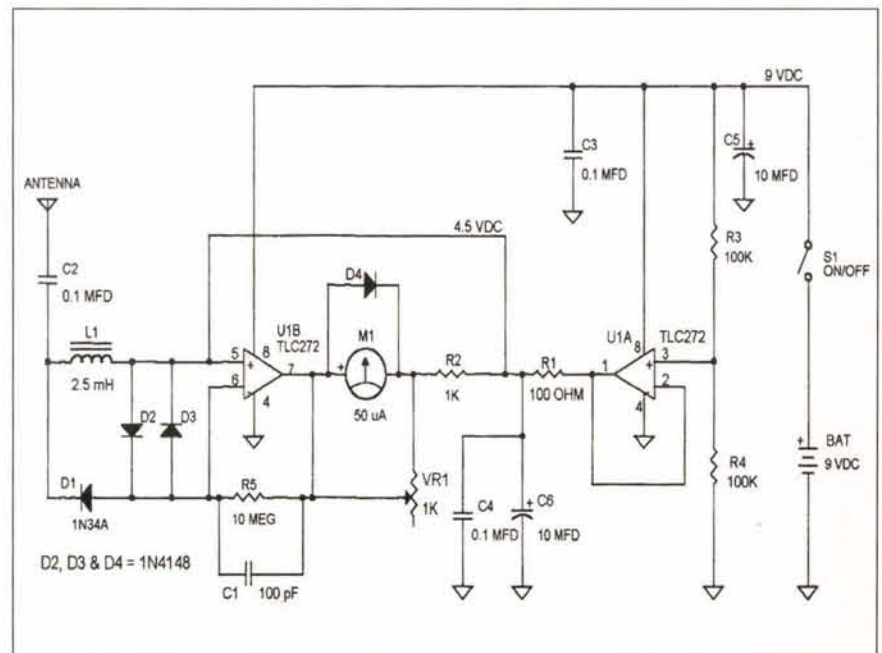
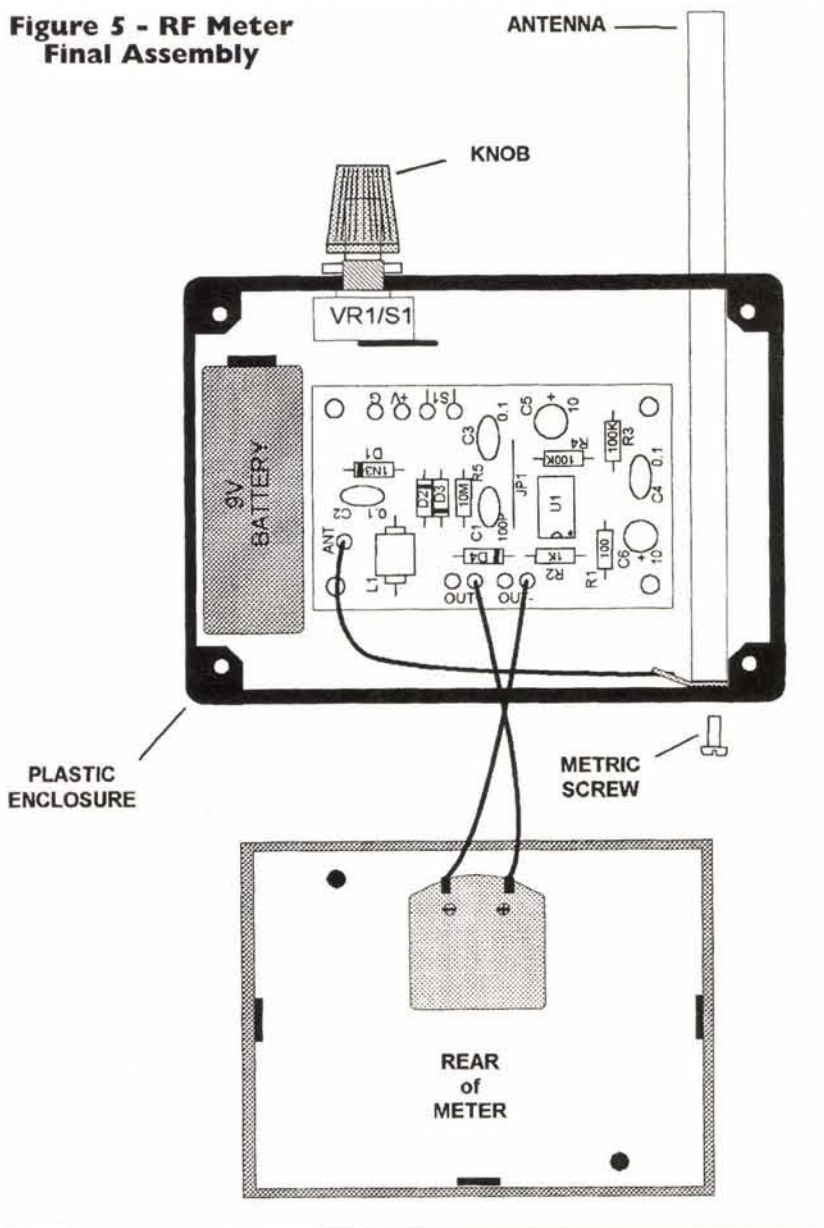


Figure 1 - RF Meter Schematic

A black and white photograph showing the internal components of a portable electronic device, likely a radio receiver, housed in a metal case. The components include a vacuum tube, various capacitors, resistors, and a power transformer, all connected by a complex network of wires. The device is resting on a wooden surface.

Figure 4 - RF Meter External Connections

Figure 5 - RF Meter Final Assembly



four inches.)

Having two wires of different colors twisted together makes it easy to maintain the required polarity between the printed circuit board, the meter, and the active terminals of the potentiometer.

The wire to the antenna is a single wire with a lug soldered to the antenna end, and the wiring from the potentiometer switch terminals to the printed circuit board is not polarity-sensitive.

Packaging

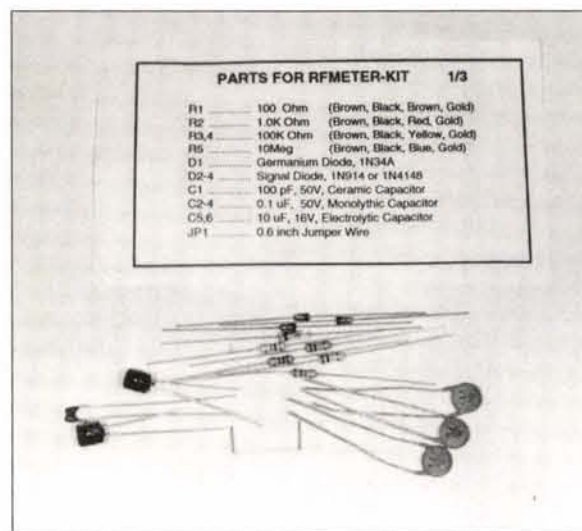
Once again, if you are building the RF Meter from the kit, the packaging is provided in the form of a 4-inch wide, 3-inch high, 1.5-inch deep plastic box with the large meter already attached to the front panel. The front view of the final assembly in the supplied cabinet is shown in Figure 5.

All necessary holes are pre-drilled in the cabinet. All hardware is provided for mounting the printed circuit board onto spacers at the back of the box. Since the spacer mounting holes pre-drilled in the back of the box may not EXACTLY match the corner mounting holes in the printed circuit board, you may need to enlarge the printed circuit board holes.

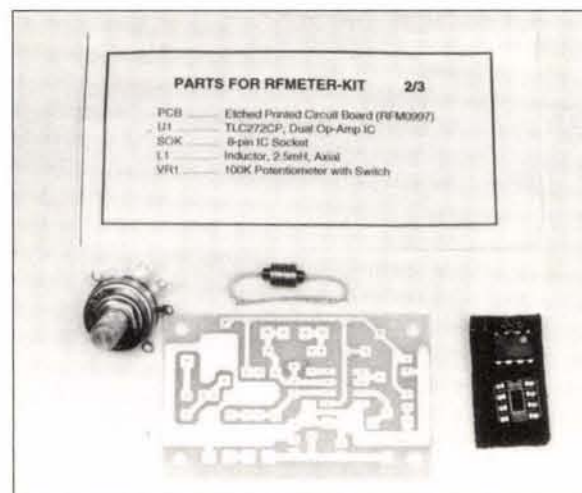
The potentiometer is mounted at the top of the box, and the fixed-length antenna is installed through a hole in the top of the box, and held with a screw into the bottom of the box, with the antenna solder lug sandwiched between the antenna and the inside of the box.

A switch on the potentiometer turns the unit ON or OFF. Install a pointer knob on the potentiometer shaft positioned so you know when the switch is OFF.

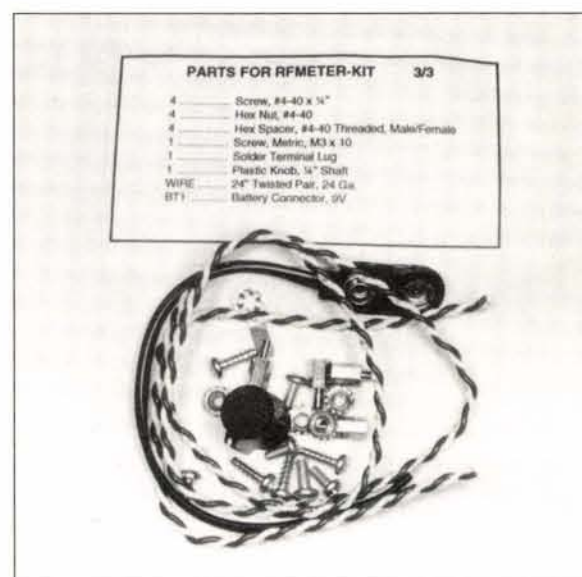
A regular nine-volt battery powers the unit. It is not necessary to use a long-life or alkaline battery since the current drain when the meter is



Parts Bag #1 has resistors, diodes, and capacitors.



Parts Bag #2 has the PCB, IC, socket, choke, and potentiometer



Parts Bag #3 has wire, miscellaneous hardware, knob, and a nine-volt battery connector.

ON and in standby operation is only a little over one milliampere. But remember to turn it OFF when not in use.

Snap the battery connector onto a nine-volt battery and install the battery as shown in Figure 5. Be sure the potentiometer is rotated fully counter-clockwise and clicks to the OFF position.

Now it's just a matter of placing the front panel with its meter onto the front of the box and holding it in place with the four screws provided.

Testing

Testing the completed RF Meter is just a matter of putting its antenna near a good source of radio frequency. Any television screen or computer monitor screen (even most laptops) will do — color or black and white.

With the RF Meter antenna well away from the TV or monitor, turn the potentiometer knob of the RF Meter clockwise until it clicks. This turns on the power and sets it to maximum sensitivity. The meter nee-

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The completed RF Meter sensitivity is controlled by a top-mounted knob.

Parts List

Resistors: Carbon film, 1/8 watt

R1.....100 ohm
R2.....1K ohm
R3, R4.....100K ohm
R5.....10 megohm
VR1.....1K ohm panel-mount potentiometer with S1 switch.

Capacitors:

C1.....100pF, 50V, ceramic
C2, C3, C4.....0.1uF, 50V, monolithic or ceramic
C5, C6.....10uF, 16V, electrolytic

Semiconductors:

U1.....TLC272CP dual op-amp integrated circuit
D1.....1N34A germanium diode.
D2, D3, D4.....1N914 or 1N4148 signal diode

Miscellaneous Items:

L1.....2.5mH axial inductor
JP1.....Wire jumper 0.6-inch
M1.....50uA DC panel mount analog meter
Antenna.....Eight-inch metal antenna
PCB.....Etched and drilled printed circuit board
Socket.....Eight-pin integrated circuit

socket

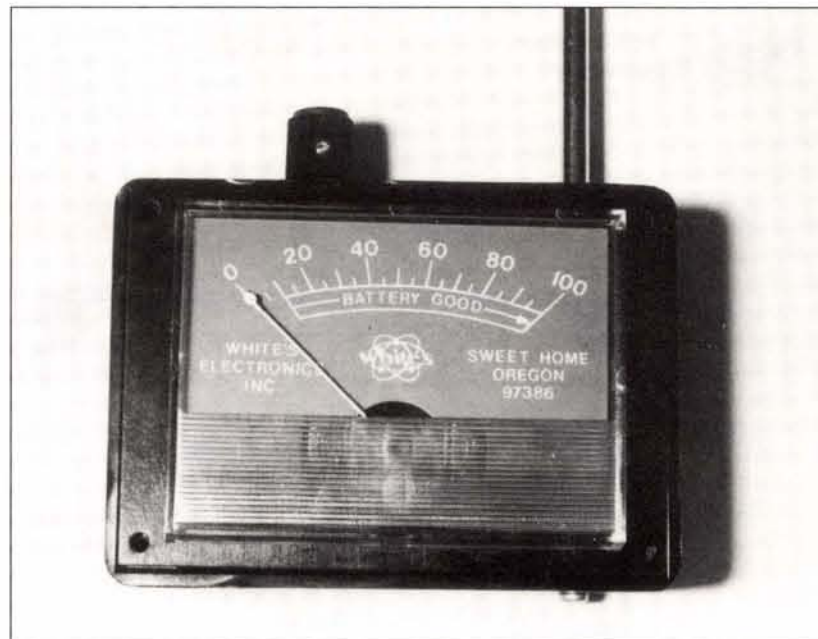
BAT.....Nine-volt battery connector
Solder terminal lug, knob for potentiometer, plastic cabinet, hardware, hook-up wire.

All the parts above, plus assembly instructions, are available from **LNS Technologies**, P.O. Box 67423, Scotts Valley, CA 95067. Phone: (831) 438-2028 8AM-5PM Pacific Time.

Website: <http://www.techkits.com>.
RFMETER-KIT is \$39.00 plus \$5.00 shipping USA, \$7.00 Canada/Mexico. CA residents add 8% sales tax.

For those desiring to build partly or fully from scratch, here are the parts most difficult to find (address, shipping, and tax as above):

RFM-PCB.....Printed circuit board.....\$7.00
RFM-METER.....50uA DC analog panel meter.....\$10.00
TLC272CP.....Dual op-amp integrated circuit.....\$4.00
ANTENNA.....Antenna and mounting screw.....\$3.50
ENCLRFM.....Drilled plastic cabinet.....\$10.00



The 50 microampere analog meter included with the kit, originally intended for use with a battery tester, is mounted on the cabinet lid.

dle will dip negative from zero. This is normal. As you turn the potentiometer fully clockwise, the needle will return to zero.

Now, as you bring the Meter antenna close to the TV or monitor screen, the needle will rise. Adjusting the proximity of the Meter antenna to the screen, and adjusting the potentiometer rotation, controls the needle swing.

Troubleshooting

What? You get NO meter needle action? Time to check various things:

- (1) Battery okay, and connector snaps secure?
- (2) Printed circuit board parts in the correct place, and properly oriented?
- (3) Solder joints good?

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(4) Make sure external connections to the printed circuit board are as shown in Figure 5, especially polarities for the meter and battery.

(5) With the potentiometer switch ON, using a voltmeter, you should have battery voltage at pin 8 of U1, and half that voltage at pin 5, with pin 4 as ground (battery negative terminal).

Using

There are a broad range of uses for the RF Meter, just so long as you are not intending to try to detect very low frequencies or very low RF

power. Actually, it will even detect and read the signal from a 900MHz wireless telephone if the RF Meter antenna is held close to the 900MHz phone antenna.

Most uses will involve detecting an RF signal, or tuning the output of a radio frequency device for maximum strength.

Some of the devices that show respectable RF Meter readings when operating in close proximity to the RF Meter antenna are microwave ovens, cordless telephones, walkie-talkies operating on various civilian bands, Citizen Band transmitters, and most amateur radio handy-talkies and transmitters. The stronger the signal, of course, the greater the

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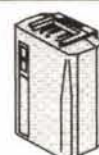
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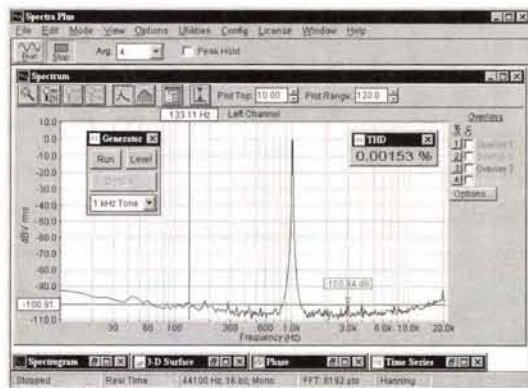
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detection range.

Slight Modification?

If you find the RF Meter is not sensitive enough for your application, you can at least double the sensitivity by using a telescoping antenna instead of the nine-inch fixed-length antenna provided with the kit or offered separately.

For example, the RadioShack Catalog Number 270-1401B Replacement Telescoping Antenna (\$3.49) has five sections and extends to 30.5 inches. However, be aware that if you use this antenna, you'll have to adapt its base for mounting from below instead of the side.

Summary

Don't expect to use this RF Meter for ham "fox hunts" of low-power hidden transmitters, or to discover "bugs" in your home or office. A considerably more sophisticated (read: "expensive") design would be needed for security sweeping. But for general use around the ham or experimenter's shack, this does a credible job. **NV**

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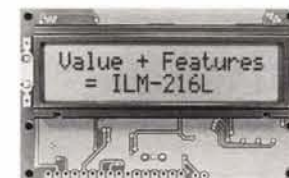
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